

Coastal Habitats in Puget Sound

Ecology of fishes in nearshore and estuarine habitats

Concern for the health of Puget Sound has intensified with recent listings of various fish and bird species under the U.S. Endangered Species Act (ESA). Local, state, federal, and Tribal governments seek improved understanding of what promotes and sustains a healthy community of indigenous species in Puget Sound to guide management and development. The U.S. Geological Survey can provide objective science, science leadership, and information transfer to guide and support strategies for conserving and restoring the biological communities of Puget Sound.



A juvenile chinook salmon taken from Puget Sound.

Puget Sound is a highly productive inland sea that is critical habitat for many populations of salmon, anadromous trout and char, and other fishes and taxa in Washington state. Dependent populations include chinook salmon, bull trout, and marbled murrelet which are listed under the ESA, coho salmon and sea-run cutthroat trout which are species of concern under ESA, and forage fishes such as Pacific herring, Pacific sandlance, and surf smelt which are key components of the marine food web.

Human development in and along Puget Sound and in the uplands of the basin over the past 150 years has drastically reduced the quantity and quality of fish habitat in the Sound and poses a threat to the health of salmonid and other fish populations with consequences for birds and marine mammals that prey on fish. Understanding the natural processes and human-induced changes in ecosystem structure and function is critical to protecting and managing the valuable natural resources of Puget Sound. Protection and management, however, are seriously hampered for lack of knowledge on the biology and habitat needs of Puget Sound fishes and other taxa.

The USGS will work to fill this knowledge gap by enhancing the science activity in the region. The science will be coordinated or done collaboratively with partners including local and state governments, Native American tribes, the U.S. Army Corps of Engineers, NOAA-Fisheries, U.S. Fish and Wildlife Service, and University of Washington.

Coastal Fish Investigations

Initially, the USGS's Western Fisheries Center is addressing two elements of Puget Sound ecology – the importance of estuarine deltas to juvenile chinook salmon, and factors affecting the distribution and dynamics of forage fishes. The first element is important because most estuarine delta habitat along the West Coast has been lost through conversion to agricultural, residential, or industrial use. The Skagit River in northern Puget Sound has lost 80% of such habitat.

We are investigating the importance of estuarine deltas through analysis of otolith microstructure from juvenile salmon. Early results from the Skagit River indicate that most of the salmon rear in the estuarine delta for at least one week; many remain for more than four weeks. A typical juvenile is 47 mm in length when it enters the estuary from upstream areas, and is 69-77mm when it emigrates to marine waters in Puget Sound. Estuarine growth is rapid and smolting fish typically increase 4-5-fold in weight while in deltaic habitats.

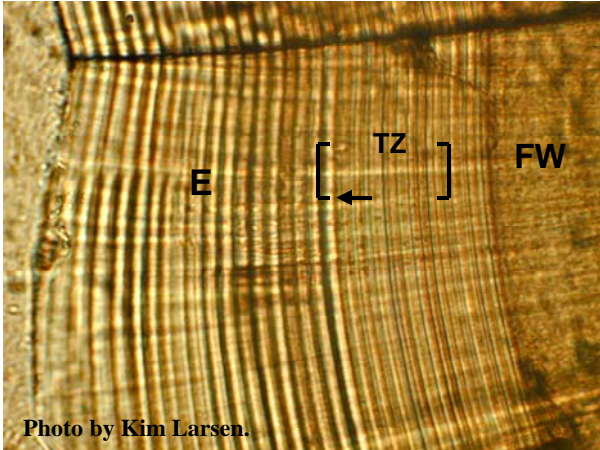
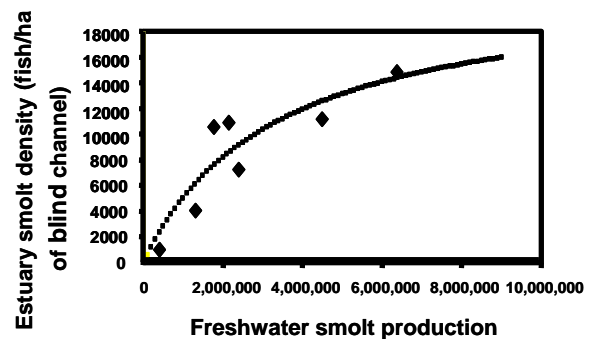


Photo by Kim Larsen.

Otoliths (fish earstones) provide fishery scientists with a recorded history (like tree rings) to study age and growth, habitat use, and stock identity of Puget Sound salmon. Pictured -- microstructure on an otolith from a juvenile chinook salmon collected in the estuarine delta of the Skagit River. The inner portion of the otolith lies to the right; the otolith increased in size as the fish grew by adding consecutive (daily) growth increments around the periphery (to the left here). The early portion of the otolith was deposited while the fish reared in freshwater and is indicated by **FW**. Transition from freshwater (upstream) to the brackish estuary is indicated by the zone marked **TZ**. Subsequent growth in the estuarine delta is indicated by **E**. The increased grow rate in the delta is indicated by the greater distances between increments in **E** as compared to **FW**.

A decreasing relationship between the density of juvenile salmon in the delta and the total number of juveniles migrating downstream ('smolts' in the figure) suggests that the amount of delta habitat limits the production of salmon in the Skagit system. This information and the observed residence times and growth in the delta indicate that restoration of delta habitat can be an effective element of the restoration program in the Skagit River. We are expanding this work to include other rivers in Puget Sound.



The estuarine delta of the Skagit River seems to approach saturation as the number of outmigrants exceeds 3,000,000 'smolts.' Data and figure from Eric Beamer.

The health of forage fish populations is vitally important to the ecology of Puget Sound because these fishes are a critical food resource for birds, mammals, and predatory fishes including salmonids. Forage fishes also may compete for food with juvenile salmon, and may serve as vectors of fish disease. Pacific herring, one of the prominent forage species in Puget Sound, have experienced substantial declines in longevity and productivity in recent years. These declines now preclude all but a trivial fishery. Our work has shown that *Ichthyophonus*, a highly pathogenic protozoan parasite, infects at least 17-55% of the herring in Puget Sound, and may be the proximate cause of the declines.

Integrated Science



Processing the catch while surface-trawling in Puget Sound.

The USGS is just beginning to develop an integrated science plan with its partners for additional research on forage and other nearshore marine fishes. Preliminary work has included collaborative efforts with NOAA-Fisheries to collect samples of Puget Sound nearshore fishes during summer 2003. The initial focus was on salmon ecology and the role of fish disease on forage fish. Future studies will investigate the physical and biological factors affecting growth and density of nearshore fish species. Such factors include physical processes determining the quantity and quality of beach habitat for spawning and for producing food; wind-driven and tidal transport of eggs and larvae to nursery areas; upwelling and nutrient delivery paths affecting production of prey; and predation. Methodologies will include remote sensing and hydroacoustic surveys coupled with trawling and other sampling activities.

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